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Humour, Laughter and Exhilaration studied with functional Magnetic Resonance Imaging (fMRI)

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Introduction: According to two recent studies employing functional magnetic resonance imaging (fMRI), the processing of humour appears to be correlated with brain activity in the left posterior middle- and inferior temporal gyri, the right posterior middle temporal gyrus, the left inferior frontal gyrus, the cerebellum (1), Broca's area and the middle frontal gyrus (2). It has also been observed that humour-related laughter could be induced by stimulating the supplementary motor cortex (in an epileptic girl undergoing monitoring with subdural electrodes (3)). Against this background, we have begun to attempt to differentiate the brain's activity during exhilaration, the perception of verbal humour, and overt laughter using fMRI.

Methods: Five young, right-handed volunteers were presented with two sets of recorded audio stimuli (via earphones) while lying in an fMRI apparatus. The first set of stimuli consisted of recorded laughter interspersed with periods of silence and "white noise". About half-way through the period of laughter, the subjects were requested to "inhibit your laughter and feelings of exhilaration." The second set of stimuli consisted of short humorous readings, alternating with neutral readings (weather reports, for example). A diagram of these two protocols is presented in **Fig. 1**.

Figure 1

| | | | | | | | | | |
|--------------------|---|---------------------|---|---------------------|---------------------------------|---------------------|---------------------|------------------------|--------------------|
| Part 1 | | | | | | | | | |
| Pause: | Recorded laughter: | Pause: | Recorded laughter: | Pause: | „White noise“: | Pause: | | | |
| 1 Min. 9.6 Sec. | 5.0 Min. Last 2 Minutes: „Suppress your exhilaration and/or laughter“ | 1 Min. 9.6 Sec. | 5.0 Min. Last 2 Minutes: „Suppress your exhilaration and/or laughter“ | 1 Min. 9.6 Sec. | (accoustic control) 2.0 Min. | 1 Min. 4.8 Sec. | | | |
| Part 2 | | | | | | | | | |
| Pause: | Neutral reading: | Funny reading: | Neutral reading: | Funny reading: | Neutral reading: | Funny reading: | Neutral reading: | Grim (muscle control): | Pause: |
| 1 Min. 1.6 Sec. | 1 Min. 32.4 Sec. | 1 Min. 32.4 Sec. | 1 Min. 32.4 Sec. | 1 Min. 32.4 Sec. | 1 Min. 32.4 Sec. | 1 Min. 32.4 Sec. | 1 Min. 32.4 Sec. | 1 Min. 1.6 Sec. | 1 Min. 1.6 Sec. |

Figure 2: Subject in MR tunnel as seen with video camera.



Throughout both parts of the experiment, subjects were requested to consciously exhibit the degrees of exhilaration and/or the degrees of humour that they were experiencing moment by moment via their "natural" facial expressions (i.e. by smiling and/or laughing at corresponding intensities). They were, however, also requested to inhibit laughter-induced head-movements. To facilitate this, their heads were immobilised in a plastic shell with an elastic band. In order to correlate the subjects' emotional states on a second-by-second basis with the fMRI measurements, the face of each subject was continually monitored by an MR-compatible video camera (4). See **Fig. 2**.

At the end of each session, the subjects were interviewed via a standardised questionnaire to determine the emotions he/she had experienced during the various stimuli. fMRI of the whole brain was performed with a 1.5 Tesla tomograph (Siemens Sonata) using echo planar imaging (28 slices, slice thickness 4 mm, 64 x 64 matrix, acquisition time 3 seconds). Statistical evaluation of the groups (involving realignment, coregistration, smoothing <8 mm> and normalisation) was carried out with SPM99b (Wellcome Department of Cognitive Neurology, London) in a combination of block diagram and event-related modes. Only the block-diagram evaluations are presented in this poster.

Results:

In both parts of the experiment, video data of the subjects' facial expressions showed a satisfactory degree of correspondence between the stimuli being presented and the responses being felt so that evaluation of the data in the block diagram mode seemed valid. This correspondence was, however, higher in Part 1 than in Part 2.

Part 1: In response to the recorded laughter, all subjects reported having been induced into a state of exhilaration which they were able to voluntarily inhibit. Unfortunately, however, the laughter-associated head movement of one of the subjects was so pronounced that the movement-correction programs employed were no longer sufficient to the task and his data could not be evaluated for this part of the experiment. In the other four subjects, maximal differences between "exhilaration" and "inhibition of exhilaration" were observed in the right frontobasal region ($x = -54$, $y = 12$, $z = 9$; $T = 4.67$, $Z = \text{inf.}$). See **Fig. 3**.

Part 2: The responses to the second set of stimuli: "humorous" vs "neutral" readings were less uniform. Some subjects tended to either laugh/smile over several sessions whereas others remained relatively non-responsive. The verbal reports of the subjects confirmed this inconsistency. In spite of this, there were highly significant differences in brain activity of the group data between the humorous vs. the neutral readings. The maximum activity for this contrast was observed was in the right temporal lobe ($x = 45$, $y = 3$, $z = -25$; $T = 13.31$; $Z = \text{inf.}$). See **Fig. 4**. Although no activations were observed in the supplementary motor cortex (3), the activations seen in Figures 3 and 4 are in general agreement with results from the recent studies (1,2) similar to those reported here.

Figure 3: Active areas during "Exhilaration" (induced by listening to recorded laughter vs. voluntary "inhibition of exhilaration.")

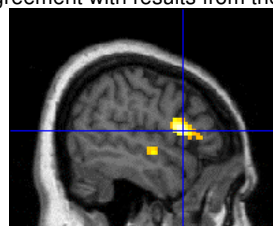
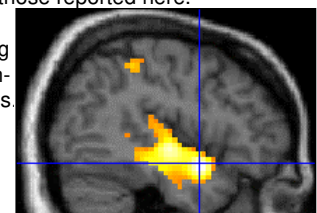


Figure 4: Active areas during humorous vs. non-humorous readings.



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